THE AMERICAN MINERALOGIST
JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA
VOL. 9 SEPTEMBER, 1924 No. 9

ADVANTAGES OF OBLIQUE ILLUMINATION IN MINERAGRAPHY[1]

W. M. MYERS, *Bureau of Mines, New Brunswick, N. J.*

Mineragraphy, the study of minerals in polished section with the metallographic microscope for the purpose of determining their identity and paragenesis, has generally been carried on under vertical illumination. Vertical illumination is commonly produced by reflecting a horizontal beam of light downward by means of a prism or mirror so that the light impinges on the mineral section at an angle of ninety degrees and is reflected back into the eye of the observer.

Oblique illumination may be produced by using a parabolic reflector; by shifting the source of vertical illumination so that the rays of light strike the mineral section at an oblique angle; or by using ordinary daylight. That these methods are unsatisfactory and little used is shown by the fact that in the literature of mineragraphy there is a marked lack of reference to oblique illumination of any kind and the great benefits which may be derived from its use have apparently been overlooked.

The only texts which have been published on mineragraphy contain a small amount of information concerning oblique illumination or how it may be produced. Murdoch's tables[2] give the characteristic colors of certain transparent minerals under oblique illumination, and Davy and Farnham[3] mention the change in color produced by inclined light and give a table containing the characteristic colors of several minerals. Other references to oblique illumination in the literature on mineragraphy are very few and indefinite in character, and this type of illumination seems to be considered of little value.

---

[1] This investigation was carried on while enrolled as a graduate student in the Department of Mineralogy, University of Michigan, Ann Arbor, Michigan.

[2] Murdoch, Joseph. Microscopical Determination of the Opaque Minerals. John Wiley and Sons. 1916.

[3] Davy and Farnham. Microscopic Examination of the Ore Minerals. McGraw-Hill Book Co. 1920.

This is undoubtedly due to the fact that no easily manipulated and thoroughly satisfactory means of illuminating a polished mineral section with light impinging at an oblique angle has been used until the *Silverman Illuminator* was devised and adapted to the metallographic microscope.

The Silverman Illuminator consists of a glass tube, bent to form a nearly complete circle. This tube is provided with a tungsten filament and exhausted and sealed forming a small electric lamp which is mounted on an aluminum ring base and provided with a three armed spring clasp. This clasp is so arranged that a slight pressure of the fingers is sufficient to draw in the arms so that the lamp may be slipped over the nose of the objective where it is firmly held by the arms upon releasing the clasp. This makes it possible to attach or remove the illuminator from the microscope in a few seconds and is a great convenience and time saver.

The illuminator is connected by means of a small flexible cord with a rheostat which in turn is connected with the standard one hundred and ten volt circuit, alternating current, commonly used for lighting purposes. The rheostat is provided with a short-circuit so that the intensity may be increased if necessary. The standard lamp with normal resistance connected with a one hundred and ten volt circuit furnishes a light of twelve watt intensity which has been found to be perfectly satisfactory for all ordinary purposes.

When the illuminator is in place and the current turned on, a ring of light is produced surrounding the objective. This light is reflected downward and impinges on the polished surface of the mineral section at an oblique angle. The light is again reflected by this polished surface and part of it passing outside of the field of the objective is lost. Sufficient light is reflected directly into the objective and to the observer's eye to furnish satisfactory illumination.

In carrying on this investigation the microscope was provided with vertical illumination by properly focusing a beam of light from a small arc lamp upon the mirror in the microscope tube. Without interfering with the arc lamp connection, the Silverman Illuminator was connected with an ordinary electric light socket and the rheostat and switches so arranged on the table beside the microscope that the illumination could be changed from vertical to oblique by operating the switches controlling the electrical connections which did not require any change in the observer's position.

None of the polished mineral specimens used had been permanently mounted and for examination it was found very convenient to temporarily mount them by placing them, polished side up, in a small crystallizing dish nearly filled with small bird shot. By placing a glass slide upon the polished section and forcing the mineral down into the shot until the glass slide touched the walls of the crystallizing dish, it was found possible to arrange the the polished section in very nearly a horizontal plane. A crystallizing dish was carefully chosen in which the height of the walls was the same at all points.

The advantages of oblique illumination over vertical illumination for the examination of polished mineral sections with the metallographic microscope will be discussed under the following headings:

(1) Observation of the normal color of minerals.

(2) Illumination of cavities.

(3) Differentiation of gangue minerals from ore minerals.

(4) Disclosure of internal structure and observation of minerals below the surface of a polished section

(5) Indication of relative hardness of minerals by emphasized relief.

(6) Observation of the action of reagents.

In order to illustrate the difference in the appearance of the field of the microscope when the illumination is changed from vertical to oblique several characteristic fields were photographed, which accompany the following discussion.

(1). *Observation of the normal color of minerals.* In general the normal colors of minerals are not revealed by vertical illumination. This is due to the fact that rays of light impinging on the polished suface of a mineral section at ninety degrees are reflected back without entering the opaque minerals and are therefore unaffected by their inherent color. This makes the identification of minerals with characteristic colors difficult and their presence is sometimes not even suspected and very erroneous results are reported.

Oblique illumination, however, reveals the mineral in its normal color. This is due to the fact that the rays of light impinging at an oblique angle on the mineral surface enter the mineral if it is transparent, or are reflected by slight irregularities on the surface, which exist on the most perfectly polished section and which cause the emergent or reflected ray to display the inherent color of the mineral.

Brilliant blue and green minerals, as azurite, malachite, or chrysocolla, appear in their normal colors and are instantaneously recognized when examined with oblique illumination. With vertical illumination they all assume various shades of gray and cannot be distinguished from the gangue minerals, nor would their existence be even suspected unless they were present in sufficient amounts to be visible to the naked eye. The red minerals like cuprite and proustite, and brown sphalerite are revealed in their normal colors, which makes their recognition extremely easy. The phenomenon is sometimes observed that vertical illumination reveals the complementary color. This is illustrated by the crimson ruby proustite which often appears to be blue when examined by vertical light.

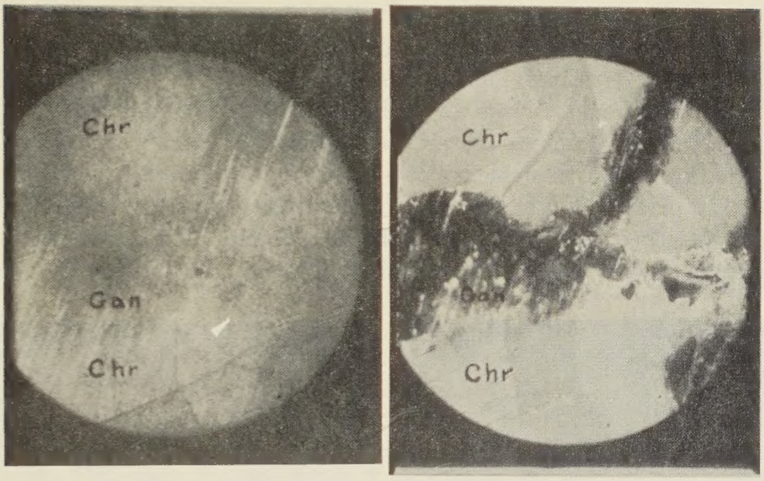
The observation of the normal color is illustrated by the accompanying photomicrographs of chrysocolla. These photomicrographs were made with the standard Bausch and Lomb microcamera and the greatest care was taken to maintain identical conditions, the only change being from vertical to oblique illumination with the Silverman Illuminator.

The specimen consisted of brilliant blue chrysocolla, a silicate of copper, in a dark brown siliceous gangue. Figure 1 shows the mineral photographed with vertical illumination in almost the same colors as it appeared to the eye. The whole field is an even gray color and apparently homogeneous and there is practically nothing to lead the observer to suspect the presence of so highly colored a mineral as chrysocolla.

Figure 2 shows the same field under oblique illumination. The chrysocolla shows its characteristic blue color, which photographed white, and the enamel-like appearance of the polished chrysocolla is revealed, so that the observer is able to identify the mineral and distinguish it from the siliceous material with which it is associated.

The same may be noticed with many colored minerals and as color is one of the most helpful physical properties by which minerals may be recognized, this revelation of normal color becomes an invaluable asset in the identification of minerals under the microscope.

(2) *Illumination of Cavities.* Microscopic cavities exist in nearly all polished mineral sections. They may be formed by fragments being torn from the section by the action of the abrasive

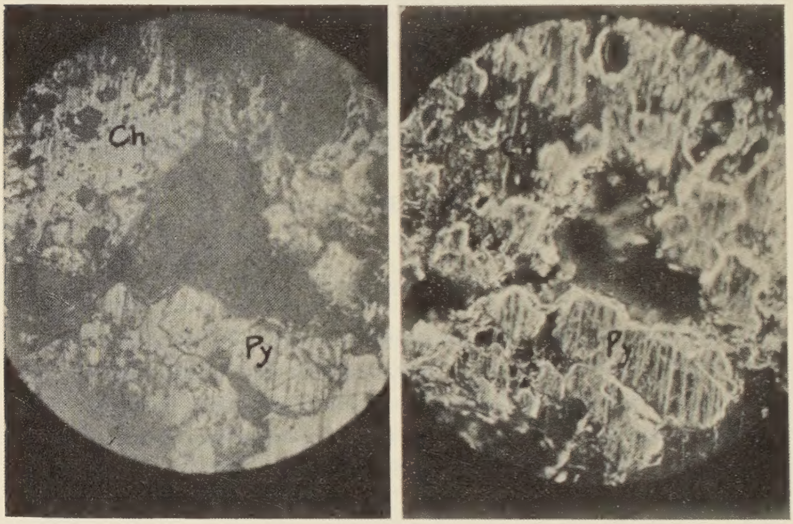


CHRYSOCOLLA FROM SEVEN DEVILS, IDAHO
FIG. 1. Vertical Illumination. Magnification 50 X.
FIG. 2. Oblique Illumination. Magnification 50 X.
Chr. = Chrysocolla; Gan. = Gangue.

on a brittle mineral. These cavities seldom exhibit any phenomenon of interest altho they may sometimes disclose the typical cleavage of a mineral which is an aid in its identification. Due to the existence of voids in practically all mineral aggregates, cavities are produced when they are intersected by the plane surface of the polished section. These are of great interest as the walls are often coated with beautiful microscopic crystals and they may contain inclusions of minerals other than those exposed at the surface.

A cavity when viewed by vertical illumination is generally not recognized as such. The rays of vertical light impinge on the bottom of the cavity and are only faintly reflected to the eye. As there is no illumination of the walls, the cavity only appears as a slight irregularity on the surface and its true significance is lost and no hint is obtained concerning its contents. On the contrary, with oblique illumination the light impinging at an oblique angle is reflected from the walls so that every corner is visible, and the walls and floor of the cavity are brilliantly illuminated. By changing the focus of the microscope the whole depth of the depression may be examined and the observer often obtains a very unusual and beautiful effect of gazing down into an opening of apparently great depth, the walls of which may be lined with very small and brilliant crystals.

The illustration shows an intergrowth of pyrite and chalcopyrite. Figure 3 shows the section illuminated with vertical illumination and little evidence of a cavity or its contents is visible Only a black spot is shown proving that nearly all the vertical rays are absorbed and very little light is reflected. Figure 4 photographed with oblique illumination discloses the outline of the cavity and the mineral crystals composing its walls and floor. As it is possible to photograph with only a small amount of the depression in focus the photograph does not disclose the whole depth of the depression, which can be readily revealed to the observer by gradually lowering the objective of the microscope. The sharpness of the focus of the surface of the section has been sacrificed to bring the walls of the cavity into view.



Pyrite and Chalcopyrite from Siegen, Prussia
Fig. 3. Vertical Illumination. Magnification 50 X.
Fig. 4. Oblique Illumination Magnification 50 X.
Py=Pyrite; Ch=Chalcopyrite.

(3) *Differentiation of gangue minerals from ore minerals.* In general the great difference between gangue and ore minerals lies

in their transparency. The common gangue minerals, as calcite, quartz and the silicates, are fairly transparent while the ore minerals vary from semi-transparent to absolutely opaque. The transparent minerals when viewed by vertical illumination appear in various shades of gray which may approach dense blackness. This is due to the fact that the vertical incident light is largely absorbed by the transparent mineral and very little light is reflected back to the eye of the observer. This makes the distinction of gangue from ore minerals nearly impossible and the identification and significance of the presence of gangue minerals is often not noted.

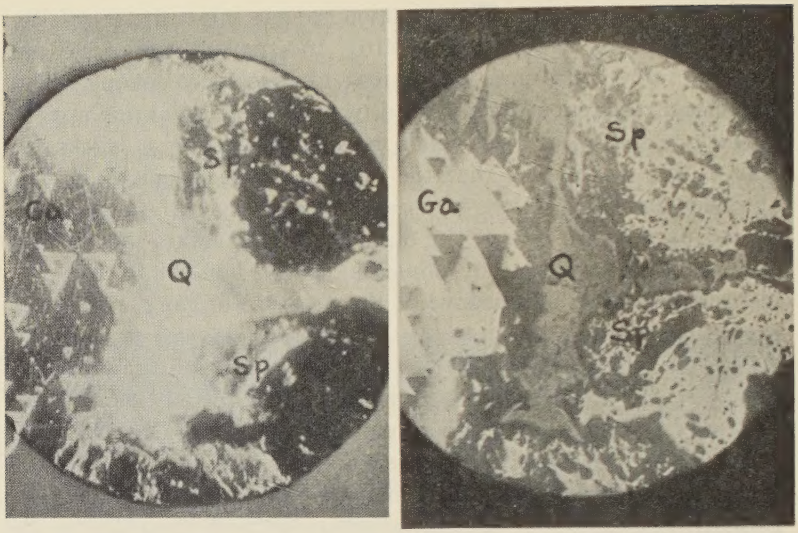
Oblique illumination, on the contrary, instantly reveals the gangue in its true transparent or translucent state. The oblique rays of light impinging at an angle enter the mineral and are reflected by cleavage and fracture planes, as well as by the contact surfaces of other minerals, so that the transparent minerals are brilliantly illuminated and their detection and identification is greatly facilitated. This also aids in making a rough quantitative estimation of the amount of ore minerals present, as well as revealing evidence concerning the intergrowth and formation of gangue and ore which is of great value in determining the paragenesis of the mineral aggregate.

The illustration was made from a polished section containing galena and sphalerite in a siliceous gangue. Figure 5 shows the field photographed by vertical illumination. Galena is easily recognized by its characteristic triangular pitting. The identification of the sphalerite is not so positive as it appears as a medium gray. The dark mineral separating the two may be any one of many minerals which show the same color under similar conditions and its identity is very uncertain.

Figure 6 photographed by oblique illumination reveals the sphalerite with its charactristic brown color and the unknown mineral is instantly recognized as being the quartz gangue which separates the two ore minerals.

(4) *Disclosure of internal structure and observation of mineral below the surface of a polished section.*

This is closely associated with the differentiation of gangue minerals from ore minerals as the underlying principle is the illumination of the transparent gangue. As the internal structure is revealed by oblique illumination, cleavage lines are disclosed



Galena, Sphalerite and Quartz from Casapalca, Peru

Fig. 5. Vertical Illumination. Magnification 50 X.

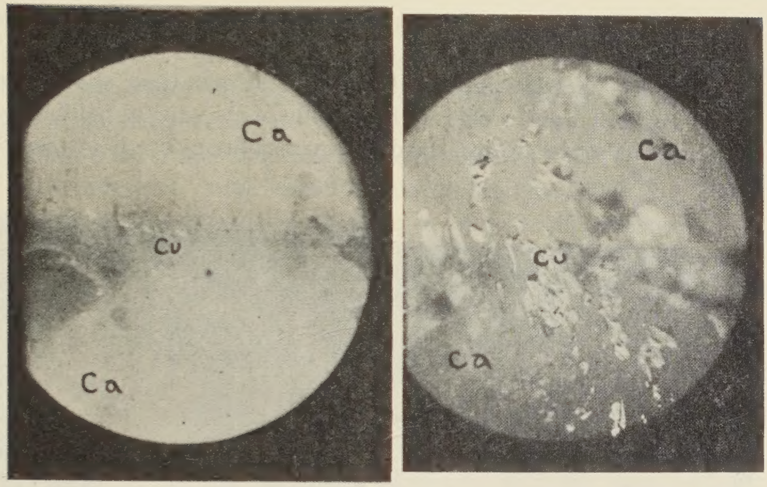
Fig. 6. Oblique Illumination. Magnification 50 X.

Ga = Galena; Sp = Sphalerite; Q = Quartz.

which are often typical of the mineral and become a valuable clue to its identification. This is very marked in minerals with a conspicuous and characteristic cleavage, as calcite or the feldspars. Particles of mineral lying below the surface which are invisible with vertical illumination become immediately visible with oblique illumination and the presence of minerals otherwise unsuspected is revealed and a more accurate estimate of the amount present may be made.

The illustration shows native copper in calcite. Figure 7 shows the polished section photographed with vertical illumination, only a few small specks of copper are visible. The field is exceptionally well illuminated as the calcite was very clear and the black ground of the mounting caused the calcite to act as a mirror and a large amount of light was reflected.

Figure 8 photographed with oblique illumination discloses the large amount of native copper actually present.



Native Copper in Calcite from Crystal Falls, Michigan

Fig. 7. Vertical Illumination. Magnification 50 X.

Fig. 8. Oblique Illumination. Magnification 50 X.

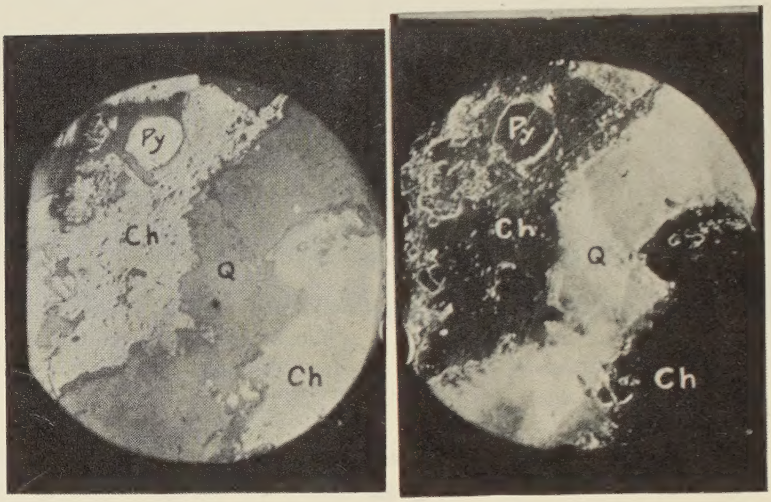
Ca = Calcite; Cu = Copper.

(5) *Indication of relative hardness by emphasized relief.* It is well known that a mineral aggregate containing two or more minerals of different hardness cannot be polished to a perfectly plane surface. The action of abrasive powders is naturally more rapid on the softer minerals and a surface is produced from which the harder minerals project in slight relief. As hardness is one of the physical properties by which minerals are identified, the recognition of relief in the polished section becomes a great aid in the identification of the minerals present. Vertical illumination illuminates the harder projecting minerals evenly, so that recognition of relief is very difficult.

Oblique illumination, on the contrary, illuminates the sides of the projecting minerals so that relief is emphasized and the difference in hardness is immediately noted. This relief may be increased by shading one side of the illuminator so that one side of the projecting mineral is brilliantly lighted and the other is in shadow.

The illustration was made from a polished section containing pyrite, chalcopyrite and quartz. Figure 9, photographed with vertical illumination, shows the pyrite entirely surrounded by chalcopyrite and so evenly illuminated that the surface appears nearly plane.

Figure 10, photographed with oblique illumination, shows the pyrite standing out in relief with one side of the crystal brilliantly illuminated and its superior hardness over chalcopyrite is instantly noted.



Pyrite, Chalcopyrite and Quartz, from Homestead, Oregon

Fig. 9. Vertical Illumination. Magnification 50 X.

Fig. 10. Oblique Illumination. Magnification 50 X.

Ch = Chalcopyrite; Py = Pyrite; Q = Quartz.

(6) *Observation of the action of reagents.* Chemical reagents, principally the common acids and the few solutions used in the laboratory determination of minerals, may be applied to the polished section and their action observed under the microscope. By adding the reagents in proper sequence quite complicated reactions may be carried out by which positive identification of minute amounts of mineral may be made.

The action of reagents is generally marked by; (a) the evolution of gas, (b) tarnishing of the polished section, (c) etching of the mineral, or (d) formation of a precipitate. All these phenomena may best be observed by oblique illumination as the gas which accompanies nearly all reactions collects on the surface of the specimen as well as on the droplet of reagent and forms a film of bubbles in which vertical illumination is absorbed and lost. The relief produced by etching and the colors of precipitates are disclosed by oblique illumination which aids in making a correct interpretation of the reaction.

The Use of the Silverman Illuminator in Photomicrography. There has been some question concerning the suitability of the Silverman Illuminator as a source of light for photomicrography. By actual use it has been found to be very satisfactory. In one respect it is a great improvement over vertical illumination in that the light is evenly distributed over the whole field so that few negatives of uneven density are produced by its use. The greatest care must be observed in using vertical illumination to obtain even distribution of light as the slightest disarrangement of the mirror used to reflect the horizontal beam of light downward results in uneven illumination of the field and the production of a poor negative.

The length of exposure necessary to produce good negatives with oblique illumination will of course depend upon local conditions, as the voltage of the circuit, the magnification used, and the character of the minerals in the field. In general the exposure with oblique illumination must be from three to six times as long as that required for vertical illumination. In exceptional cases where a mineral of great transparency is being photographed, the exposure may be less due to the fact that the absorption of vertical light is so great that little light is reflected to the photographic plate.

No positive statement as to exposures may be made until standardized equipment is universally used, as the system of vertical illumination commonly employed may vary greatly depending upon the experience of each individual investigator. Slight differences in the type of lamp used, the distance removed from the microscope, and the system of condensing lens employed, will produce such great differences in the intensity of illumination of the field that no two observers will obtain concordant results.

Oblique illumination can be used with magnifications as high as 400X. Beyond this point it is difficult to obtain satisfactory illumination as the rays of light cannot pass around the nose of the objective sufficiently to illuminate the field. This is not a serious objection as most investigations are carried on at comparatively low magnifications.

It is not the intention of this paper to maintain that vertical illumination has no value and should be discarded, but to attract the attention of students of mineragraphy to the advantages which may be derived from oblique illumination and to suggest that this type of illumination may be frequently used with profit to supplement observations made with vertical illumination.

NEW OPTICAL DATA FOR ANALYZED SUSSEXITE*

E. Poitevin and H. V. Ellsworth, *Canada Geological Survey and University of Toronto*

On comparing the indices given for sussexite,[1] $2Mn(Mg)O_2 B_2O_3H_2O$, with those of Camsellite,[2] $2MgO.B_2O_3.H_2O$, there is a marked discrepancy evident when one considers the specific refractivity of the constituent radicals. Manganese oxide has a higher specific refractivity than magnesium oxide and therefore, sussexite should have the higher indices, contrary to the published values as indicated below.

	α	β	γ	Elongation
Sussexite	1.541±0.003	1.545±0.003	1.554±0.003	+
Camsellite	1.575±0.005	————	1.649±0.005	−

Having recently obtained a good specimen of sussexite from Franklin Furnace, New Jersey, U. S. A., the original locality, we have determined the indices of refraction of this mineral on a sample of known chemical composition.

The specimen consists chiefly of willemite, franklinite and zincite with a coating of white, fibrous sussexite on what appears to be a slickensided surface. A sample 0.4 g. in weight was obtained by scratching the fibres with a steel point. Half of this was used for the general analysis and half for a direct water determination. Microscopic examination of the sample showed that only a few minute grains of the associated minerals were present.

---

* Published with the permission of the Director, Geological Survey, Canada.

[1] Larsen: Microscopic Determination of the Non-opaque Minerals, *U. S. Geol. Survey, Bull.* **679.**

[2] Ellsworth and Poitevin: Camsellite, a New Borate Mineral from British Columbia, Canada. *Trans. Royal Soc. Canada,* **May,** 1921.

METHODS OF ANALYSIS.—After volatilizing B_2O_3 by means of methyl alcohol the silica was removed by two evaporations. Manganese was next separated by a modification of the Williams method, (HNO_3 $KClO_3$), dissolved, precipitated and weighed as pyrophosphate. Iron and alumina were precipitated twice by ammonia in ammonium chloride solution and after weighing, the minute amount of manganese present was determined by the persulfate colorimetric method. Calcium was precipitated as oxalate and magnesium as phosphate, the small amount of manganese present in the magnesium pyrophosphate being determined by the colorimeter method and the necessary corrections applied. On evaporating the strongly ammoniacal filtrate from the magnesium phosphate only about a third of the zinc was precipitated even by taking the solution to dryness. Adjustment of the solution for neutrality, acidity, or alkalinity, by means of a delicate universal indicator failed to produce any further precipitate. This seems to indicate that the phosphate precipitation cannot be trusted when only a few milligrams of zinc are concerned, though for large amounts it is a very good method. The zinc remaining in solution was brought down by H_2S in a slightly alkaline solution and weighed as oxide. The presence of large amounts of B_2O_3 was confirmed by the usual test.

The analysis gave the following results:

	ELLSWORTH	PENFIELD	BRUSH
MnO	37.58	38.08	40.10
MgO	16.29	15.92	17.03
ZnO	3.87	3.24	.....
Fe_2O_3	0.60	.....	.....
CaO	0.10	.....	.....
SiO_2	0.50	.....	.....
H_2O 110−	0.10	.....	.....
H_2O 110+	7.80	8.53	9.59
B_2O_3 (diff.)	33.16	33.31	31.89

On referring to the original work of Brush[3] and Penfield[4] it is seen that this analysis agrees well with that of Penfield. Brush precipitated manganese by means of bromine water and it was no doubt contaminated by zinc, magnesium and calcium.

PYROGNOSTICS.—It may be worth mentioning that while the fusibility of the mineral is low (F 2 as given by Brush and Penfield) when exposed in the open flame and oxidation of the manganese occurs, it appears to be much more difficultly fusible when heated in a closed tube, the dehydrated mineral remaining white and fusing to a nearly colorless glass.

---

[3] Brush, Geo. J.; *Am. J. Sci.*, **46**, 240 (1868).

[4] Penfield, S. V.; *Am. J. Sci.*, **36**, 323 (1888).

Dr. W. F. Ferrier, one of the earliest collectors of sussexite from Franklin Furnace, recently told the writers that a large number of specimens sold or exchanged as sussexite years ago were really chrysotile serpentine. It seems that the specimen supposed to be sussexite from the University of California examined by Larsen must have been chrysotile. The two minerals are so much alike that in the absence of optical data they can only be identified by chemical tests.

Larsen's figures for chrysotile serpentine and sussexite are as follows:

	α	β	γ	Elongation
Sussexite[5]	1.541±0.003	1.545±0.003	1.554±0.003	+
Chrysotile serpentine[6]	1.542±0.005		1.552±0.005	+

leaving no doubt that the specimen examined by Larsen was really chrysotile.

The sussexite material analysed by Ellsworth was examined under the microscope and its optical properties are found to be in agreement with its chemical composition when compared with camsellite as follows:

	α	γ	Elongation
Camsellite	1.575±0.005	1.649±0.005	−
Sussexite	1.639±0.003	1.704±0.003	−

Thus camsellite and sussexite may be easily distinguished from chrysotile which has positive elongation.

[5] *Idem.* p. 140.

[6] *Idem* p. 133.

AN IMPROVED WENTWORTH RECORDING MICROMETER

Walter F. Hunt, *University of Michigan*

In one of the more recent issues of the Journal of Geology[1] Professor Chester K. Wentworth described a very ingenious mechanical device in the nature of a recording micrometer for rock analysis. This instrument, when attached to the stage of a petrographic microscope, will measure from one to five mineral constituents, record and add the results in a single operation.

---

[1] *J. Geology*, **31**, 228-232 (1923).

Through the kindness of Professor Wentworth the writer was able to secure the loan of this instrument for a thorough trial and to verify the claims made for it. Naturally, after considerable experience with the micrometer, it became apparent that the addition of certain refinements would still further increase the efficiency of this valuable instrument. In fact several improvements were suggested by Professor Wentworth in his article which might be followed by anyone wishing to duplicate this piece of apparatus.

In order that the recording micrometer with these refinements might be available to all parties interested in quantitative mineralogy, the writer enlisted the services of Mr. Ralph Miller, instrument-designer and President of Eberbach & Son Co., Ann Arbor, Michigan, and it is largely due to his skill that this improved micrometer is now on the market.

The object of this short note is merely to state the nature of some of these refinements and to point out how readily the information gained by the use of this instrument can be applied in connection with Professor Johannsen's Quantitative System.[2]

The standard instrument as now manufactured is constructed of brass with a dull nickel finish. Three sliding clamps, easily adjusted by means of a key, attach the micrometer securely to the stage of the petrographic microscope. Such attachment renders unnecessary the drilling of holes in the stage, at least for most types of microscopes.[3] Figure 1 shows the instrument mounted on a microscope and in proper position to take readings. The micrometer in its present form is one inch shorter and weighs approximately 80 grams less than the previously described instrument. The slide holder and long, double, tension springs, which pull the slide carriage to the right, are additional refinements when compared with the mechanism previously employed.

[2] Albert Johannsen; Essentials for the Microscopical Determination of Rock-Forming Minerals and Rocks, page 40. The University of Chicago Press, 1922.

[3] Mr. Clarence Ross, geologist, U. S. Geological survey, who has used one of these instruments informs the writer that with his microscope, which contains a friction ring in the stage, attachment was secured by threaded holes and thumb screws. Mr. Ross also suggests that for rocks with decided schistosity a rotating slide holder would be a desirable refinement. The present instrument can be used for schistose rocks by cutting the slide and rotating it in the slide carrier.

The most noteworthy improvement, however, pertains to the manner of recording complete turns of the dials used to record the constituent minerals. In the original instrument this was accomplished by counting the threads exposed after having previously calibrated the micrometer for one to twelve turns of the dial. In the present form the complete revolutions of the graduated micrometer heads can be read off directly by the horizontal displacement measured in half and whole millimeters, the same as in micrometer calipers. Figure 2 shows the instrument with the five graduated micrometer heads, all in the zero position.

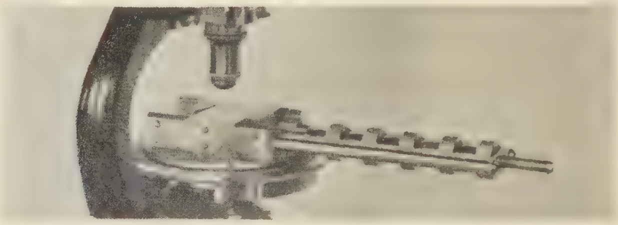


Figure 1

The pitch of the screw used is 0.5mm. and with one hundred divisions on each micrometer head a definite value of 0.005 mm. is established for each small division. While in general computations involving the measurements of mineral grains are wholly relative in character, still in determining the actual size of phenocrysts or grain size of sandstones it is very desirable to know the absolute value of each division of the micrometer head.

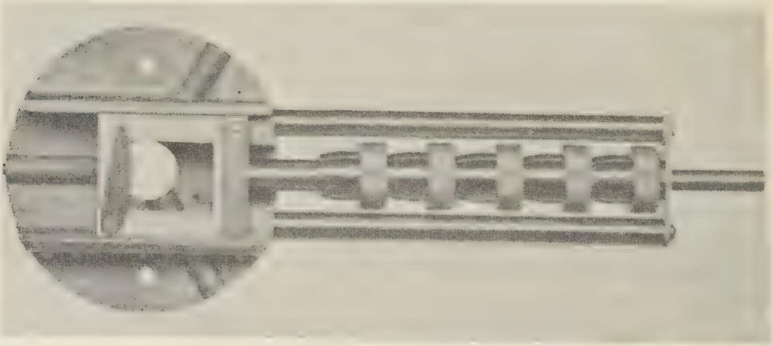


Figure 2

The concluding two examples will illustrate applications of the use of this instrument in quantitative petrography. Twelve traverses across the slide at intervals of about 1/2 mm. were taken in each case.[4] The values obtained and the necessary computations are as follows:

(a) Rock section of gabbro from Risör, Norway

Designation	Minerals	Micrometer readings	Per cent	
Plag.	Bytownite	18957	58.1	
Mafites	Hornblende	5831	17.9	41.9%
	Pyroxenes (enstatite and diallage)	4699	14.4	
	Olivine	2640	8.1	
	Magnetite, Pyrite	503	1.5	
		32630	100.0	

Leucocrates = 58.1% = *Class 2* (between 95 and 50 per cent). Plagioclase = $Ab_{20}An_{80}$ = *Order 3* (between $Ab_{50}An_{50}$ and Ab_5An_{95}). As no quartz is present the family falls in the row of Families 9, 10, 11 or 12. With no orthoclase, therefore *Family 12;* or the rock number is *2.3.12* (olivine norite).

(b) Rock section of syenite from Miask, Ural Mts.

Designation	Minerals	Micrometer readings	Per cent	
KF.	Orthoclase, Microcline and Microperthite	13321	42.7	89.8%
Foids.	Nephelite, Sodalite	6326	20.3	
	Cancrinite	4687	15.0	
Plag.	Albite	3676	11.8	
Mafites	Biotite	2979	9.5	
	Magnetite	186	0.6	
Auxiliaries	Apatite, Zircon	32	0.1	
		31207	100.0	

Leucocrates = 89.8% = *Class 2* (between 95 and 50 per cent). Plagioclase = $Ab_{94}An_6$ = *Order 1* (between Ab_{100} An_0 and Ab_{95} An_5). In recalculating Quarfeloids (KF. + Foids. + Plag.) to 100%, Foids = 39.3%. The Family with 39.3% Foids. falls in the row of Families 17, 18, 19 or 20. KF. and Plag. recalculated to 100% gives KF. = 78.2%; therefore *Family 18*, or the rock number is *2.1.18* (albite-nephelite-syenite).

---

[4] These readings were taken by Mr. Floyd Poindexter, graduate student in the Department of Mineralogy.

CHROMIUM-COLORED MARGARITE FROM MONTGOMERY COUNTY, MARYLAND

Earl V. Shannon, *U. S. National Museum*[1]

An old and long abandoned chromite mine located 1 mile west of Etchison Post Office, in the northern tip of Montgomery County, Maryland, is interesting mineralogically, as having furnished the fuchsite and chromium-bearing tourmaline described by Gill.[2] This locality was visited by the writer in November, 1923, in company with Messrs. W. F. Foshag, Edward Sampson, and Waldemar T. Schaller. No difficulty was experienced in locating the old mine and a search of the dumps resulted in the finding of a few typical specimens of chromiferous tourmaline and some especially good specimens of fuchsite.

In addition to these minerals a third green substance was obtained which has been found, upon examination, to be margarite. Since margarite has not heretofore been mentioned from any Maryland locality the present note is published to record the occurrence.

The margarite forms narrow branching veinlets, seldom exceeding 2 mm. in width, in a dark chocolate-colored serpentine which contains minutely disseminated chromite. It is finely foliated and, in the specimen, has a deep emerald-green color with somewhat pearly luster. By hand picking and separating with heavy solutions and an electromagnet a pure sample was prepared and, when ground, this was found to have a pale nickel-green color. Upon analysis this purified sample gave the following results:

SiO_2	30.74
Al_2O_3	50.24
Cr_2O_3	0.72
CaO	10.68
MgO	2.70
H_2O+110°C.	4.90
Total	99.98

The composition is that of margarite, the green color evidently being due to the chromium content. Optically the mineral is biaxial and negative with 2V medium small, averaging about 30°.

---

[1] Published by permission of the Secretary of the Smithsonian Institution. A second preliminary paper on the minerals of Maryland being studied in cooperation with the Maryland State Geological Survey.

[2] A. C. Gill. *Johns Hopkins Univ. Circular* No. 75, 1889.

Dispersion $\rho < \nu$ strong; crossed dispersion likewise strong. The indices of refraction are approximately $\alpha = 1.625$, $\beta = 1.633$, $\gamma = 1.635$. Plates on edge show extinction inclined 4° to 9° to the trace of the cleavage. The thicker grains seen under the microscope are faintly colored and seem to show pleochroism in pale blue-green tints across the lamination and blue parallel to the elongation.

PROCEEDINGS OF SOCIETIES

NEW YORK MINERALOGICAL CLUB

Regular Monthly Meeting of March 12, 1924

A regular monthly meeting of the New York Mineralogical Club was held in the East Assembly Room of the American Museum of Natural History on the evening of Wednesday, March 12th, at 8:15 P.M. The President, Dr. George F. Kunz, presided and there was an attendance of 26 members.

The President read a letter from the secretary of the Museum of the City of New York asking for contributions of local minerals to be added to the Museum's Collection. It was moved that the Club take action individually on this request and that donations of minerals be brought to the next meeting. The motion was carried.

The President then appointed a nominating committee consisting of Messrs. Manchester, Wintringham and Whitehouse to report at the next meeting on nominations for officers for the ensuing year. The recording secretary reported on behalf of the Gratacap Memorial Committee and read a tentative draft of the inscription for the tablet which was submitted to the members present for comment and discussion. On motion of Mr. Stanton, duly carried, the Gratacap Memorial Committee was requested: (1) to obtain information as to the size, position and character of the tablet; (2) that sketches be obtained and submitted for the joint approval of the Club and the Museum; and (3) that the club treasurer be authorized to solicit subscriptions toward defraying the cost of this memorial.

The President announced the death of Dr. Wallace Goold Levison, corresponding secretary and delegate to the council of the New York Academy from the Club, and read the following sketch of his life:

> Dr. Wallace Goold Levison was born at his late residence, 1435 Pacific Street, Brooklyn, on the 27th of November, 1846. He graduated from the public schools of Brooklyn and from Cooper Union in 1865. He also obtained the degree of B.S. from Harvard in 1870. He was director of the Cooper Union Chemical Laboratories from 1871-1884; and a fellow and life member of the New York Academy of Sciences. He was one of the earliest members of the New York Mineralogical Club, and for years its secretary, 1903-1918, and corresponding secretary, 1918-1924. He was a member of the Brooklyn Institute and was connected with the Mineralogical section as long as that was in existence. He was a member of the Brooklyn Academy of Photography, and its President from 1887-1890.

After graduation he devoted his entire time to the study of chemical and electric arc lamps, the patent for which he sold for $15,000. He was an expert in photographing luminous objects, and was interested in the fluoresence and phosphoresence of minerals. He undertook the classification of luminous substances, and collected quite a mass of material, virtually enough to make a volume, which was unfortunately never published. He prepared a paper on the origin and sequence of the New Jersey traps. He was also chairman of the committee for the standardization of trays for mineralogical specimens and collections.

He constructed what is believed to be the first motion picture camera, and aided in the invention of the portable camera. At the time he made his first motion picture camera celluloid negatives had not been invented, but he foresaw such a development and stipulated in his application for a patent that such films could be used, if that type of negative were developed. He held patents on many inventions, among them the spectropolariscope, which it was claimed made possible the investigation of the mineral composition of planets by means of polarized light He was unusually orderly and systematic; he did not believe it necessary to have all the apparatus about him, and kept them in a dry cellar in boxes properly labeled, the only instrument at hand being the one actually in use.

Dr. Levison had suffered from heart trouble for more than ten years, and his death ultimately was caused by arterio-sclerosis. He never married and lived at the home of his sister, Mrs. Josephine Grimwood and his brother Chancellor Goold Levison. Funeral services were held on March 12th in St. Bartholomew's Church.

Dr. Kunz spoke of the bibliography of Dr. Levison, which he had obtained from Dr. Ralph W. Tower, librarian of the New York Academy of Sciences and suggested that this bibliography be published by the Club. Motion by the recording secretary to this effect was carried. A motion was then passed that the President appoint a Committee to prepare a suitable resolution on the death of Dr. Levison. Dr. Kunz appointed on this committee Messrs. Manchester, Ashby and Stanton.

The President then introduced Dr T. A. Jaggar, Jr., Director of the Hawaiian Volcano Observatory at Kilauea, who delivered an address on "*Mineral Processes on Hot Lava.*" Dr. Jaggar spoke of the new science involving the processes taking place in the earth and dwelt on the importance of such observations in the field as are being conducted at the Kilauea Observatory. He discussed at length the scoriaceous and fluid phases of lava and advanced some highly interesting and suggestive theories regarding them. He compared, by means of lantern slides, some typical volcanic mass formations with luna landscapes and called attention to the luster of certain lava masses on the moon's surface as suggesting the luster of the scoriaceous phase of lava.

Throughout his address Dr. Jaggar used for illustration many beautifully colored lantern slides of Hawaiian volcanic activity. In reply to questions he explained the formation of Pele's hair and Pele's tears. A vote of thanks was tendered to Dr. Jaggar for his most interesting and original address.

Mr. Manchester offered a correction to his statement made at a former meeting that pyrope garnets of gem quality had been found at Bedford Quarries, Westchester Co., N. Y. He stated that he had since discovered that the garnet material which he had reported upon did not originate at this locality but had been brought from elsewhere.

HERBERT P. WHITLOCK, *Recording Secretary.*

ABSTRACTS

CELESTITE AND STRONTIANITE FROM THE PERMIAN DEPOSITS OF THE DISTRICT OF SVIAZHSK, GOVT. KAZAN. P. DRAVERT. *Ann. Géol. Min. Russie*, **17**, 75-7 (1916); thru *Mineral. Abstr.*, **2**, 137.

Pale blue celestite crystals are found in cavities in dolomite at Pechischi. The color becomes paler on a short exposure to daylight (10 days). Heating to 180° for a few minutes causes complete decolorization. An analysis gave: $SrSO_4$ 97.98, $BaSO_4$ 1.41, $CaSO_4$ 0.52, Fe trace, sum 99.91; sp. gr. 3.94. Celestite also occurs in the interior of brachiopod shells at Morkvashi. Strontianite sometimes forms a coating on the celestite crystals near Pechishchi. E. F. H.

OPTICAL CONSTANTS OF SOME BOHEMIAN MINERALS. BOHUSLAV JEŽEK. *Rozpravy České Akad.*, cl. 2, **30**, no. 35, 5 pp. (1921); thru *Mineral. Abstr.*, **2**, 139.

Pyrope had the following indices:

	n_{Li}	n_{Na}	n_{Tl}	n_{Blue}
Měrunice	1.73885	1.74436	1.74763	1.75968
Podsedice	1.73806	1.74301	1.74696	1.75748
Dlažkovice	1.73882	1.74507	1.75048	1.75800
Třibivlice	1.73721	1.74385	1.75150	1.76004
Železnice	1.73960	1.74563	1.75080	1.76012
Lhota Bradlecka	1.73914	1.74606	1.75258	1.76134

Beryl from Pisek: (Na) ω 1.5744-1.5751, ε 1.5692-1.5701. Nephelite from Podhorn: (Na) ω 1.54886-1.54912, ε 1.54327-1 54382. E. F. H.

CRYSTAL STRUCTURE OF TITANIUM, ZIRCONIUM, CERIUM, THORIUM AND OSMIUM. A. W. HULL. *Phys. Rev.* **18**, 88-9, (1921).

Structures were determined from X-ray powder diffraction patterns. Ti, Zr, Ce, and Os are hexagonal close packed, the axial ratios, and side and height of the unit triangular prisms being respectively: Ti, 1.59, 2.97 Å., 4.72 Å. Zr, 1.59, 3.23, 5.14. Ce, 1.62, 3.65, 5.96. Os, 1.59, 2.71, 4.32. Th is face-centered cubic, with a side for the unit cube of 5.04 Å. Ce has a face-centered cubic form, side 5.12 Å., as well as its hexagonal form. But the apparent dimorphism may be due to impurities.
E. F. H.

PHOSPHORESCENCE AND MELTING OF THE SULPHIDES OF THE SECOND GROUP, PARTICULARLY ZINC SULPHIDE. ERICH TIEDE AND ARTHUR SCHLEEDE. *Centr. Min.*, **1921**, 154-158.

Pure preparations of ZnS, CdS, HgS, MgS, CaS, SrS, and BaS, were fused in a steel bomb in an atmosphere of nitrogen at 150 atm. pressure, temp. ranging from 1450-2000°C. All fusions except CdS and HgS showed phosphorescence.
OTTO VON SCHLICHTEN.

OPTICAL AND LIGHT-ELECTRICAL INVESTIGATIONS ON CINNABAR. H. ROSE. *Z. Krist.*, **56**, 427-8, (1921).

Cinnabar has a high *n*, strong dispersion and double refraction, as well as considerable light-electrical conductivity. It is therefore well suited for a study (here presented) of the relation between that conductivity and absorption in doubly refracting crystals. E. F. H.

ELECTRIC CONDUCTIVITY OF SOME CRYSTALS AND THE INFLUENCE OF RADIATION. II. W. C. Röntgen. *Ann. Physik,* **64,** 1-195, (1921); thru *Chem. Absts.,* **15,** 2250-1.

NaCl xls. at ordinary temperature show a small electric conductivity. Experiments did not prove whether or not this was due to secondary influences. If exposed to X-rays or γ rays, NaCl xls. have a much greater conductivity, in light, after the treatment. Naturally colored NaCl xls., in light, show the same phenomenon. Only the absorbed light is of influence on the conductivity. Sylvite and fluorite behave similarly. E. F. H.

THE PROPERTIES OF PLASTIC CRYSTALS OF AMMONIUM NITRATE. W. N. Bond. *Phil. Mag.,* **41,** 1-21, (1921).

NH_4NO_3 crystallizes from aqueous solution at room temperature in long acicular crystals. These can be bent or twisted and are slightly elastic. The bending is probably plastic in nature, and a local rotational atomic adjustment occurs when the crystal is bent. The structure is but little changed in the process. E. F. H.

NINTH LIST OF NEW MINERAL NAMES. L. J. Spencer. *Mineralog. Mag.,* **19**(98), 334-354 (1922).

A list of 147 mineral names arranged alphabetically which have appeared in the recent literature. Many represent new mineral species. The name is followed by a brief description of the mineral and a reference to the original publication.
W. F. H.

THE HOT WATER SUPPLY OF THE HOT SPRINGS, ARKANSAS. Kirk Bryan. *J. Geology,* **30,**(6), 425-49 (1922).

The mineral content of 46 springs varies from 170-310 parts per million. In only a few instances is it below 270 or above 290. SiO_2 varies from 32.5-52.3; Ca 26-50; HCO_3 94-172; SO_4 6-28; Cl 2.36-3.33; also small amts of Mg, K, and Na were found and traces of B, I, and Br. No evidence of radium salts was detected, altho the intensity of radioactivity varies from 0.5-265.8. The temp. measurements range from 95.4-147°F. W. F. H.

ON GLAUCONITE FROM THE GREEN SAND NEAR LEWES, SUSSEX; THE CONSTITUTION OF GLAUCONITE. A. F. Hallimond. With a chemical analysis by E. G. Radley. *Mineralog. Mag.,* **19**(98), 330-3(1922).

The grains, separated by sieving, had a mean refractive index of 1.62 and sp.gr. 2.70. Analysis gave: SiO_2 48.12; Al_2O_3 9.16; Fe_2O_3 19.10; FeO 3.47 CaO 0.76; MgO 2.36; K_2O 7.08; Na_2O 0.22; $H_2O(105°)$ 4.78; $H_2O > 105°$ 5.28. In order to determine the constitution of the mineral many analyses were recalculated in mol. proportions. The proportion of alkalies was found to be quite constant and no evidence of the substitution of these by H_2O or by the magnesia group was detected. There is considerable replacement of the K_2O by Na_2O. In the groups R_2O_3 and RO the mol. proportions are not constant and indicate no relationship to the silica and alkalies. If the (Fe,Mg)O and $(Fe,Al)_2O_3$ are considered as mutually replaceable, the ratios obtained lead to the formula, $R_2O.\ 4(R_2O_3,RO).\ 10\ SiO_2.\ n\ H_2O$, the ratio of bases to silica being 1:2. W. F. H.